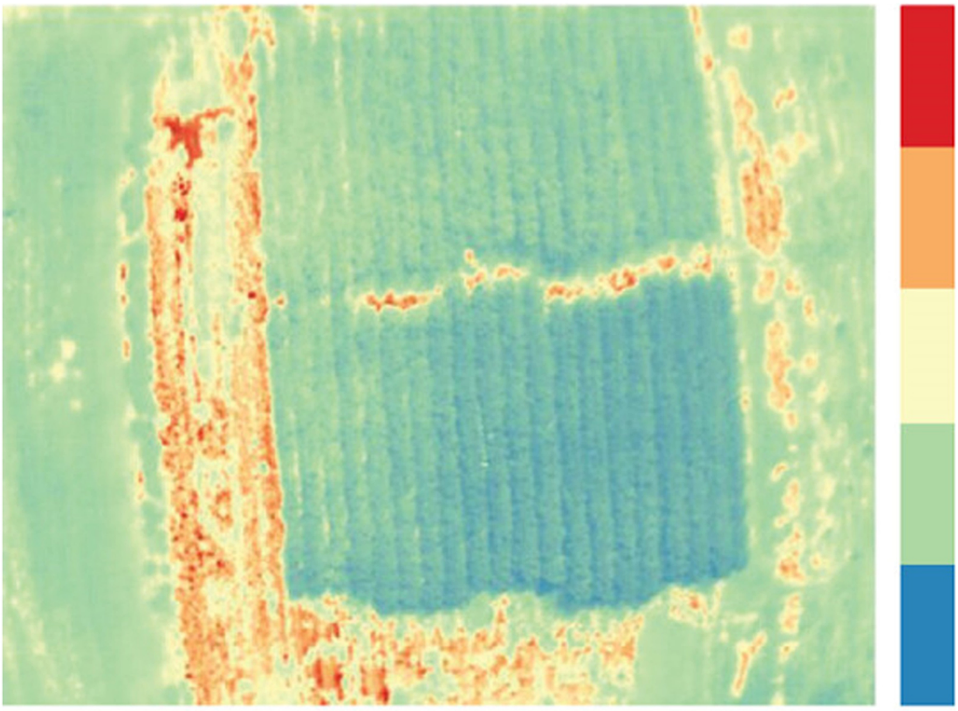
Science Societies

Turning drone maps into profit: Targeted irrigation, reduced risk, and smart in-season decisions

Part 3 of the series 'Seeing the Stress from Above'

By Francia Ravelombola, Harmeet Singh-Bakala, Maiara Oliveira, Grover Shannon, and Feng Lin

April 30, 2026



Top: Drone map of a cotton field. Source: Chang et al. (2020): https://doi.org/10.1155/2020/8899325. CC BY 4.0: https://creativecommons.org/licenses/by/4.0/. Bottom: The value comes when you connect maps like the one above to irrigation scheduling, variable-rate irrigation, and in-season input decisions. Photo of irrigated cotton field courtesy of Wikimedia Commons/Alabama Extension. CC0 1.0: https://creativecommons.org/publicdomain/zero/1.0/deed.en.

Drone-based RGB, multispectral, and thermal imagery can reveal crop stress earlier and more precisely than ground scouting, allowing farmers to make better in-season decisions about irrigation, inputs, and field inspections. By turning these maps into real-time management zones, growers can reduce over-watering, target problem areas, lower risk, and improve both water efficiency and profitability across variable fields. This is the third and final article in our "Seeing the Stress from Above" series.

Earn 0.5 CEUs in Soil & Water Management by reading the article and taking the quiz.

In the Mid-South, water is usually the first limiting factor and the biggest power bill. Corn, soybean, cotton, and rice all depend on timely irrigation, but most fields are a patchwork of soils, slopes, and seepage. Some acres are almost always too dry, others stay wet too long, and it is easy to overwater just to protect the weakest spots.

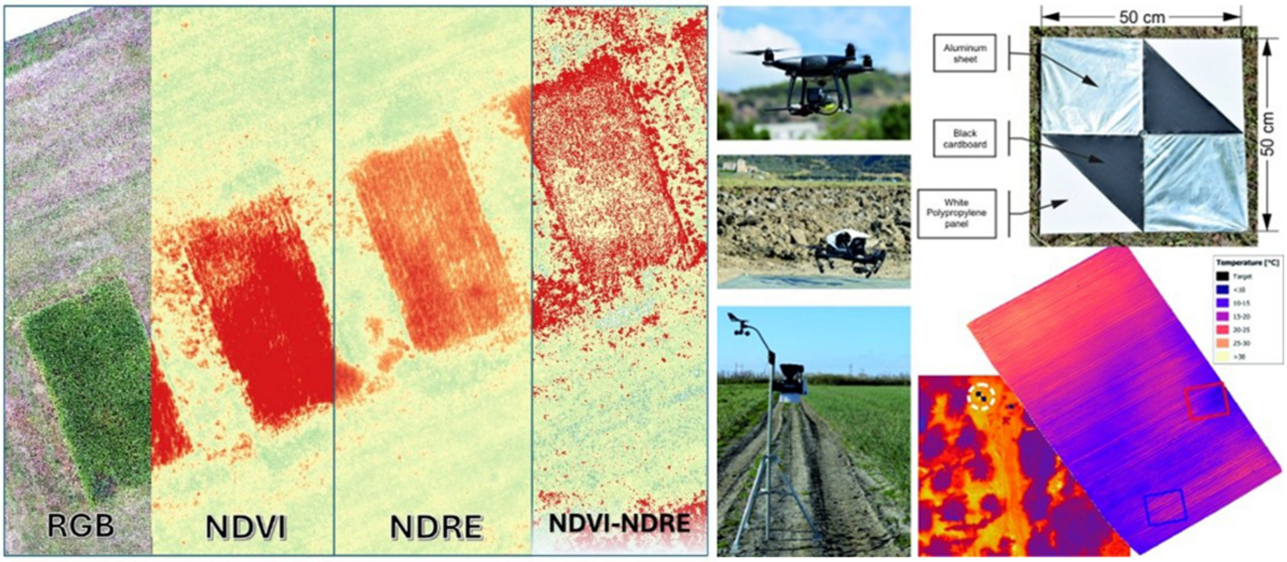
In the previous article in this series, we focused on generating data from unmanned aerial vehicles (UAVs). This final article in the series is about the "what now": how to turn those drone images into concrete, field-level decisions that protect yield, trim pumping hours, and reduce risk. Imagery from UAVs—RGB, multispectral, and thermal—can show where the crop is stressed days or weeks before you see it from the turnrow (Zhang et al., 2019; Stutsel et al., 2021; Sharma et al., 2025). The value comes when you connect those maps to irrigation scheduling, variable-rate irrigation (VRI), and in-season input decisions (Yadav et al., 2024).

In Mississippi, researchers at Mississippi State University are putting this into practice across multiple crops. In soybeans, drones are used to map real deer damage and controlled defoliation to pinpoint how much leaf loss a plant can survive before replanting becomes the better option. In corn, thermal cameras on UAVs are paired with tiny "eye button" sensors on the stalks to ground-truth canopy temperature and define stress thresholds for turning the pivot on. Similar approaches are being used to map glyphosate-resistant pigweed pressure in cotton and to monitor nodulation and stress in peanuts.

In Missouri, drones are moving from "toy" to tool in both research and on-farm use. Extension specialists compare them to the first UTVs on farms: once producers see the time and fuel savings from aerial scouting, they rarely go back. At the University of Missouri, teams are combining multispectral drone imagery with machine learning to estimate chlorophyll and nitrogen status in corn, helping growers apply fertilizer where and when it pays the most and eventually extending the same logic to soybeans and wheat.

What drone maps actually tell you

A single drone flight can give far more than a pretty field picture. It produces several "decision layers" that help understand what is really happening in the crop. The first layer is a standard RGB image, which looks like a normal photo but can reveal stand gaps, drowned-out spots, lodged plants, and weed patches. The second layer comes from vegetation indices such as NDVI, NDRE, or VARI. These indices use reflected light to estimate crop vigor. Areas with low index values often point to poor rooting, nutrient deficiencies, compaction, or early water stress problems that may not yet be visible on the ground. A third layer is thermal imagery, which records canopy temperature. Hotter spots usually mean plants are struggling to cool themselves because the root zone is too dry, damaged, or restricted. When these layers are viewed together, a quick drone flight turns into a powerful scouting tool, helping farmers target irrigation, fertilizer, and field checks where they are needed most.



Left: *Multispectral drone imagery showing the same field as RGB, NDVI, NDRE, and an NDVI-NDRE difference map. NDVI and NDRE highlight crop vigor and chlorophyll status while the NDVI-NDRE map pinpoints "hidden" stress or maturity zones that guide irrigation, fertilization, and harvest decisions. Source: Adapted from Wageningen University & Research, LinkedIn post (2025).* ***Right:*** *Drone-based thermal imaging workflow. UAV and ground-based thermal systems in the field, a 50 × 50 cm multi-material calibration panel, and a canopy temperature map derived from the thermal images. Source: https://doi.org/10.3390/rs12091491.*

Using UAV imagery for irrigation scheduling

Not every part of a pivot or furrow-irrigated field runs out of water at the same time. Sandier ridges, coarser streaks, wheel tracks, and field edges usually stress first while heavier bottoms may still be almost muddy. When irrigation is scheduled only by the calendar or a single soil sensor, it is easy to overwater the "tight" spots and underwater the lighter ground that actually drives yield loss. Drone imagery gives a field-wide view of where stress really starts. A practical approach for growers is simple: fly just before a key irrigation decision at stages like V10 and R2 in corn, early pod in soybean, or squaring in cotton; map NDVI and, and ideally, canopy temperature; and identify "early stress" zones that light up first. Those sensitive areas that appear stressed or dry on the monitoring map should be the signal to start the irrigation, even if the rest of the field still appears healthy from the edge.

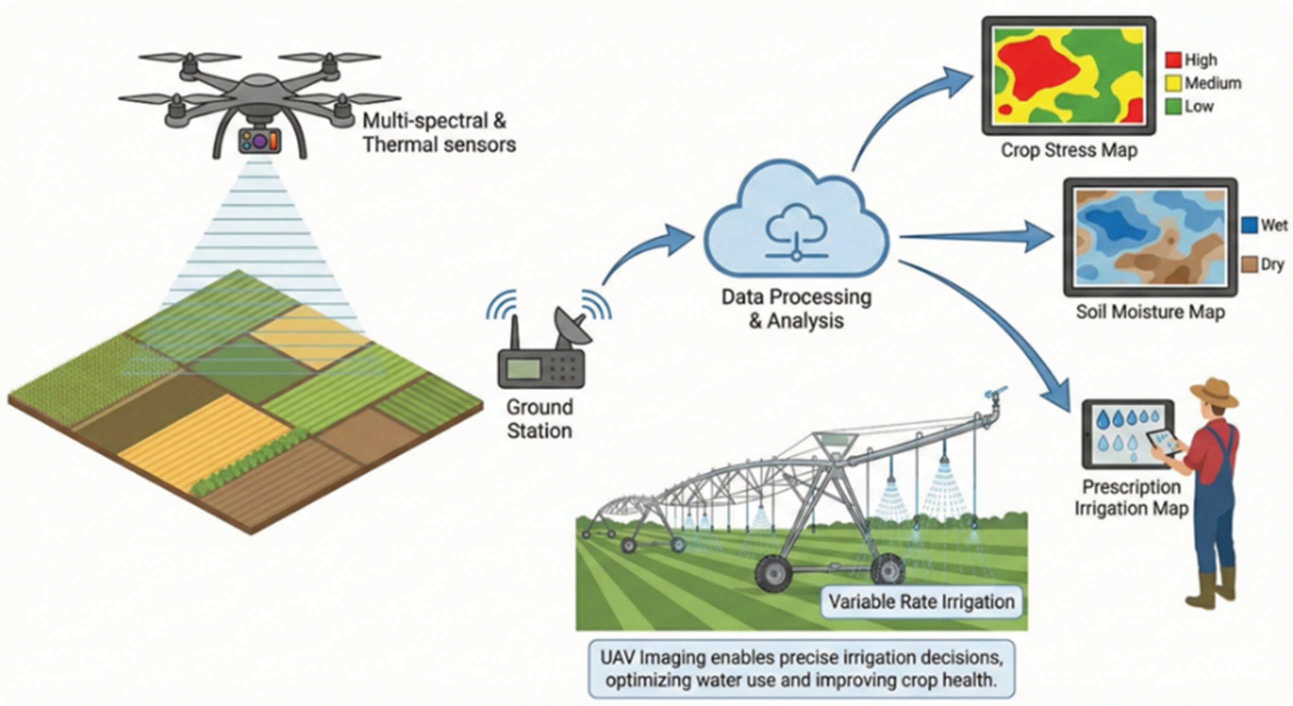
A follow-up one to three days after irrigation or rainfall will confirm if those problem zones have recovered or if the persistent stress points to deeper issues like soil compaction, shallow root zones, or nutrient deficiencies instead of just lack of water.

Improving variable-rate irrigation and multiple-inlet rice irrigation

Most variable-rate irrigation (VRI) and multiple-inlet rice irrigation (MIRI) systems start with static maps: soil electrical conductivity, yield history, and topography. Those are valuable, but they do not fully capture how this year's rainfall, rooting depth, and compaction are shaping water demand right now. Drones help move from "design once" to "adjust as you go."

In the Mid-South, extension specialists in Arkansas and the Mississippi Delta report that some growers now hire drone operators when laying out polypipe or row-rice MIRI, using elevation and imagery to fine-tune hole sizes and bay spacing from the start (Hehemann, 2022). Early in the season, once the young plants are actively growing, farmers use NDVI maps (which show plant health and greenness) to confirm their initial watering zones by checking which zones are strong and which are weak compared with what their old soil maps predicted. This data helps them make early adjustments to their system settings, such as changing zone boundaries or modifying the flow through MIRI holes.

Later, when the weather is hot and the plants are drinking the most water, another round of mapping often reveals that areas they thought were "medium" soil are actually struggling this year, wilting first and staying hotter longer and acting more like light, sandy soil. Under a pivot, this means they slow the application over those hot sectors to apply more water and speed up or trim the water where the crop looks greener and cooler. In rice, this may mean opening the gates or modifying the levees in bays that are constantly running dry while closing the gates slightly on the bays that get too much water. Crucially, the irrigation hardware is still doing what it was built to do, but the zones are now driven by how the crop behaves in real time, not just by static soil data collected years ago.



Turning drone images into water decisions. Multispectral and thermal sensors on a UAV map crop stress and soil moisture across the field, feeding cloud-based analysis that converts NDVI and canopy temperature into management zones. These maps then drive variable-rate and prescription irrigation, so dry, high-risk acres get more water, wetter zones get less, and every pass of the pivot is tuned to in-season crop demand.

Finding root zone problems that water alone won't fix

When a spot on the drone map stays pale or hot even after a good rain or full irrigation, the problem is usually not water on the surface, but something in the root zone. Multispectral and thermal imagery, combined with what farmers already know about their fields, is becoming a powerful way to "see" these belowground limits. At Arkansas turf and research sites, thermal and multispectral cameras help separate true drought stress from poor drainage or compaction, so managers know whether to turn on the water or fix the soil (Lovett, 2023). The same logic applies in Mid-South row crops. Instead of digging random holes, growers can use the map to pick a few "problem pixels" and a few nearby "good" ones. A quick assessment using a shovel, penetrometer, and simple infiltration test at those problem spots usually tells a clear story about what is wrong with the soil. This contrast in soil health then guides the long-term solutions, such as performing deep tillage only where it will be most effective or using cover crops to naturally open the soil.

Using drone imagery to diagnose system problems

Sometimes the issue is neither the soil nor the weather at all. Drone maps are remarkably good at revealing problems that are almost invisible from the ground. Extension specialists at the University of Nebraska show aerial photos of furrow-irrigated fields where a dike at the tail end caused water to back up; the top and bottom of the field were fine, but the middle stayed dry and yield suffered (Thompson et al., 2017). Michigan State University Extension has encouraged irrigators to use camera or drone video of center-pivot water patterns to spot leaky spans, plugged or worn nozzles, and pressure drops long before they show up on the yield map (Kelley, 2022).

These same maps also help decide where extra fertilizer, sprays, or water will actually pay off. When an area shows up as both hot on the thermal map and low in vigor on NDVI or NDRE, it is a strong sign of real crop stress, not just random noise. The same idea applies to foliar feeds and fungicides: weak but well-watered zones are good candidates for foliar nutrition while very dense, high-vigor patches may justify targeted fungicide or growth regulator applications to reduce disease and lodging risk. Follow-up flights 24–72 hours after an input pass add a final quality check. By re-mapping NDVI and canopy temperature, growers can see whether stressed zones actually greened up or stayed pale. If only part of a zone recovers, it may indicate uneven application or deeper root-zone problems. If most of the zone improves, the imagery confirms that the decision was effective and worth repeating.

References

Hehemann, W. (2022). *Farmers: Hiring drone technology can help increase efficiency of row crop operations.* UAPB News. https://uapbnews.wordpress.com/2022/07/28/farmers-hiring-drone-technology-can-help-increase-efficiency-of-row-crop-operations%EF%BF%BC/

Kelley, L. (2022). *Camera or drone video can help identify center pivot sprinkler repairs.* Michigan State University Extension.

https://www.canr.msu.edu/news/irrigation-uniformity-check-taco-bell-or-eye-in-the-sky

Lovett, J. (2023). *Arkansas turfgrass research shows drones adaptable to golf course water, labor issues.* Arkansas Agricultural Experiment Station, University of Arkansas System Division of Agriculture. https://aaes.uada.edu/news/turfgrass-drones-aid-water-management/

Sharma, H., Sidhu, H., & Bhowmik, A. (2025). Remote Sensing Using Unmanned Aerial Vehicles for Water Stress Detection: A Review Focusing on Specialty Crops. *Drones*, *9*(4), 241.

Stutsel, B., Johansen, K., Malbéteau, Y. M., & McCabe, M. F. (2021). Detecting plant stress using thermal and optical imagery from an unoccupied aerial vehicle. *Frontiers In Plant Science*, *12*, 734944.

Thompson, L. J., Shi, Y., & Ferguson, R. B. (2017). Getting started with drones in agriculture. University of Nebraska–Lincoln Extension. https://extensionpubs.unl.edu/publication/g2296/na/html/view

Yadav, M., Vashisht, B. B., Vullaganti, N., Kumar, P., Jalota, S. K., Kumar, A., & Kaushik, P. (2024). UAV-enabled approaches for irrigation scheduling and water body characterization. *Agricultural Water Management*, *304*, 109091.

Zhang, L., Niu, Y., Zhang, H., Han, W., Li, G., Tang, J., & Peng, X. (2019). Maize canopy temperature extracted from UAV thermal and RGB imagery and its application in water stress monitoring. *Frontiers in plant science*, *10*, 1270.

Self-study CEU quiz

Earn 0.5 CEU in Soil & Water Management by taking the quiz for the article. For your convenience, the quiz is printed below. The CEU can be purchased individually, or you can access as part of your Online Classroom Subscription.

1. What advantage do drone images provide compared with ground-based scouting?

a. They eliminate the need for yield monitoring.

b. They detect crop stress earlier and across the whole field.

c. They replace soil sampling for nutrient management.

d. They automatically generate irrigation prescriptions.

2. What type of information do vegetation indices like NDVI and NDRE provide?

a. Exact soil moisture content by depth.

b. Measurements of soil texture and compaction.

c. Predictions of final grain yield.

d. Estimates of crop vigor and chlorophyll status.

3. When drone maps show early stress in only part of a field, what does the article recommend?

a. Wait until visual symptoms appear everywhere.

b. Irrigate the entire field at the maximum rate.

c. Use stressed areas as the signal to initiate irrigation.

d. Ignore those zones unless yield loss is visible.

4. What does persistent stress after rainfall or irrigation most often indicate?

a. Surface evaporation losses.

b. Sensor malfunction or mapping error.

c. Root-zone limitations such as compaction or poor drainage.

d. Delayed crop maturity across the field.

5. How can follow-up drone flights after fertilizer or irrigation applications add value?

a. By confirming whether stressed zones actually improved.

b. By predicting market prices for inputs.

c. By replacing tissue and soil testing.

d. By determining final yield before harvest.

This quiz was drafted with AI assistance and reviewed by humans for accuracy and appropriateness.